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# Project Based Learning: The teaching method of the future, RQ: How can students explore their interests and passions while learning electrical circuits through a school project?

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**ABSTRACT**

This article investigates how we can increase students' learning in the area of electrical circuits with the strategy of allowing students to explore their personal interests and passions in a PBL approach.

One of PBL's main standing points is giving students voice and choice, which will encourage them to have a more open mind posture due to the fact that they are doing something of interest to them, so they can be authentic to themselves whilst doing it.

The *Put a Spark In It!* project used the *design thinking* approach as the main path for students learning. In the beginning students were invited to choose a context that they wanted to focus on and understand its main stakeholders by developing interviews and collecting data. Then, they defined the main problem they wanted to solve and ideated a solution. Finally, they built the prototype, along with a scientific article and a creative poster explaining how the device worked.

Throughout the whole process, creativity and reflection were explored, from the first week of class, when students were encouraged to reflect on their personal relationship with electrical energy to the final days when they developed the final products.

The goal of this article is to demonstrate, through qualitative analysis and interview processes, how a school project can allow a deeper understanding of electrical circuits when students have a stronger motivation, especially when they are developing something personal to them.

**Keywords:** PBL, Electrical Circuits, Innovative Learning, Student Based Learning, Design Thinking Approach

## 1. INTRODUCTION

Project Based Learning is a teaching method in which elaborate real-world problems are used as the mechanism to promote student learning of concepts and principles as opposed to direct presentation of facts and concepts (University of Illinois, n.d.). The main theme connecting these various uses is the real-world problem. PBL can also be based on the Design Thinking Method. Design thinking is an unsystematic, interactive process that teams use to understand users, challenge assumptions, redefine problems and create ingenious solutions to prototype and test. It is most useful to tackle problems that are vague or unknown (Interaction Design Foundation, n.d.). This article takes place in the Avenues The World School's "*Put a Spark In*

*It!"* 9th grade project. As part of the PBL method, the students had an essential question to answer: "What are the roles of energy in our lives?". This question was applied to all of the project subjects, including science. To answer this question in scientific matters, the students were assigned into groups to develop a solution to solve a problem of their choice, using electrical circuits. The groups were based on the type of problems they wanted to solve. The students investigating the results and effects of PBL in a classroom are: Ana Clara Voltani, Nathalia Costa and Merle Rentink. The mentor of our classes and article is Carla Gomes, a secondary division science teacher at Avenues São Paulo.

## 2.  DESCRIPTION

### 2.1 Personal interest

In order to explore and solve the real-world problems and essential questions of the PBL, the students were invited to choose a problem and solution based on their personal interests. The project's main focus is to make students feel involved and more engaged with their learning, so their learning process will actually become a more meaningful experience to them. They were arranged in groups, based on what they wanted to solve and develop. A few examples of what problems students decided to work with were cell phone addiction, COVID-19 related, sports issues, etc. In order to research and understand more about the impacts of this learning method, after the end of the project,  we interviewed a sample of the students and asked them about what their experiences with Project Based Learning were like. We interviewed 27 people out of the total 80 students who participated (26.6%). 85% of them confirmed that choosing what they were going to present based on their personal interests was important for them to learn. 85.2% said that they felt engaged with the project approach. On a scale from 1-5, 55.6% of the students said their experiences with the project were a 4. And, generally, their favorite part of it was having to come up with a solution for a problem of their choice, therefore having the opportunity to help other people while using their own perspectives to do so.

### 2.2 Design thinking approach

The Design Thinking approach is a teaching and learning method used to understand the students, challenge assumptions, redefine problems and create innovative solutions to prototype and test. This method is composed of five stages: Empathize, Define, Ideate, Prototype and Test (Interaction Design Foundation, n.d.). In order to create the prototypes and find creative solutions for their problems of choice, the students conducted interviews and researches with their chosen audience, so they could understand them better. The interviews were conducted in order to understand the audience, what were their desires and needs, challenges, limitations, etc. Understanding the audience was a key element to the development of the project and prototype, afterall, they were the ones that needed help finding solutions to their issues. The students were encouraged to design their prototypes based on how they could help the people they interviewed and even themselves. According to studies (*Design Thinking*,

n.d.), the Design Thinking approach is better to be used in a classroom rather than the usual thinking process because it focuses on developing students' creative confidence. Design thinking connects real-world problem-solving within classroom environments. Teachers and students engage in hands-on activities that rely on developing empathy, promoting action, encouraging ideation, developing metacognitive awareness and fostering active problem solving (*Design Thinking*, n.d.).

### 2.3 Student focused learning

This project also explored a student focused learning environment, where the student's role in the classroom is not as passive as in traditional learning environments: they were encouraged to stand up for themselves, asking questions, presenting new topics and going out of their way in talking to new teachers to make sure their hypotheses were possible.

The student focused learning environment has been proven to be more efficient than regular methods (EJEL, 2012), being a more active way for students to learn just as much as ever.

Teachers, however, contrary to what may seem, were not disposable, but in the classroom as a source of support for students to look to when in doubt. The teacher is encouraged to share their experiences and go off text book learning, which has been stated to be more fulfilling to teachers as opposed to a traditional classroom (International Journal of STEM Education, 2018). As opposed to the traditional learning method, in PBL, the educators are focused on being facilitators and not as someone who knows all the topics, which focuses even more on the students' both engagement and learning.

### 2.4 The project

The project was based on an essential question that was the base for the students' work until the very end of it. The base subjects explored were English, Science and WAM (Wellness and Movement). Students were first introduced to circuits as a very open topic, in an equally open discussion. They were encouraged to come up with research questions that would explain how circuits work, always having an active role in the classroom. Following the Design Thinking process, students first started grouping based on their chosen audience, and once they got together, it was time to empathize with the stakeholders through meaningful conversations and surveys, further understanding the desires, challenges and inspirations they had. After understanding the audience, students defined a specific problem and started to brainstorm ways to solve it. After thinking of a potential solution for the problem, students began researching, seeing if anyone had come up with this before, since originality was something that the teachers wanted to see in the final product. Along with the design thinking process, students were exposed to many activities in which they independently learned new content and applied it to specific situations, for example, they had to design an electrical circuit of a store, which led them to learn about series and parallel, ohm's law, electrical power, etc. They were also asked to build circuits with components that had different functionalities, such as sensors, DC motors, switches, buzzers, power supplies, multimeters, etc. All these different activities were meant to develop the foundation they needed to propose solutions for the problems they were trying to solve. After that,  each group had different roles for each member, one of the members was

the graphic designer; the other was the engineer and the last one, the researcher. The researcher started writing an article on how their prototype actually worked and the science and research behind it, as well as additional information as to how they wished to proceed in the project. The engineer was responsible for building the electrical circuit and assembling the prototype, including handling with materials, such as wood, plastic and rubber, basically everything needed in the building process of the prototype. Finally, the graphic designer was responsible for creating a visual poster that would show the solution and explain within a small amount of text what steps were taken to get to the final product. The process of receiving feedback and being able to resubmit was constant throughout the whole process, in the prototype, in the poster and in the article.

### 2.5 Mental health

The persistent pressure to succeed, often measured by grades or a GPA, can contribute to students being sleep-deprived, anxious, and even engaging in self-harm (Feldman, 2020). The process of grading related to this project had the goal to lower those rates of anxiety and make students feel more comfortable and engaged in their learning. The grading process itself was based on grading in different topics like discussions, note taking, participation in class. It included homework in their performance grades and also gave students a second chance for those who wanted or needed to improve their past assignments, instead of just grading them in tests and quizzes. According to ASCD.org, schools make learning less stressful when they create a space where students can take risks without penalty, not feel constantly scrutinized, and not have the pressure to perform perfectly every class period every day. Of course, they do want to clearly enforce and encourage certain behaviors and discourage others, but they have an almost infinite universe of conversations and consequences within their classroom and school to do so (Feldman, 2020).

## 3. MAIN RESULTS

As previously stated, we conducted interviews with the students to understand how their experience was with PBL (project based learning). These interviews were done half three months after the project finished. 85% of the students said that it was very important for them to choose the topic for their final project. There was a wide range of topics in the energy/electricity project of 4 weeks. Students got to work in groups of about 2-4 students to create their final product.

The graph below shows the topics that students chose for their final products. We can see that there are many different interests and by using this teaching method (PBL) we can get students to be more engaged during the project. Each of the groups used their creativity to come up with a solution to a problem that interests them:

## final project topics
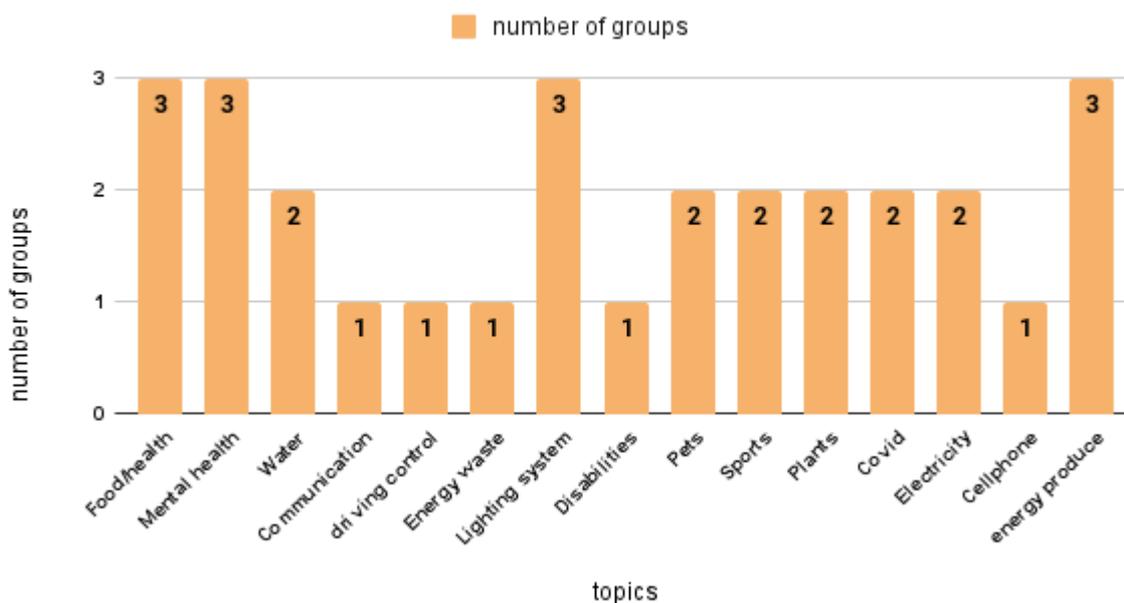


Here is what students remembered learning about during this 4 week project. We can clearly state that most (20 out of 27) students said circuits. This was one of the main topics of the project and an essential element in the final product. The other topics were not as easily remembered, but together, the students were able to name all topics studied during the project.

## What students leaned/remembered
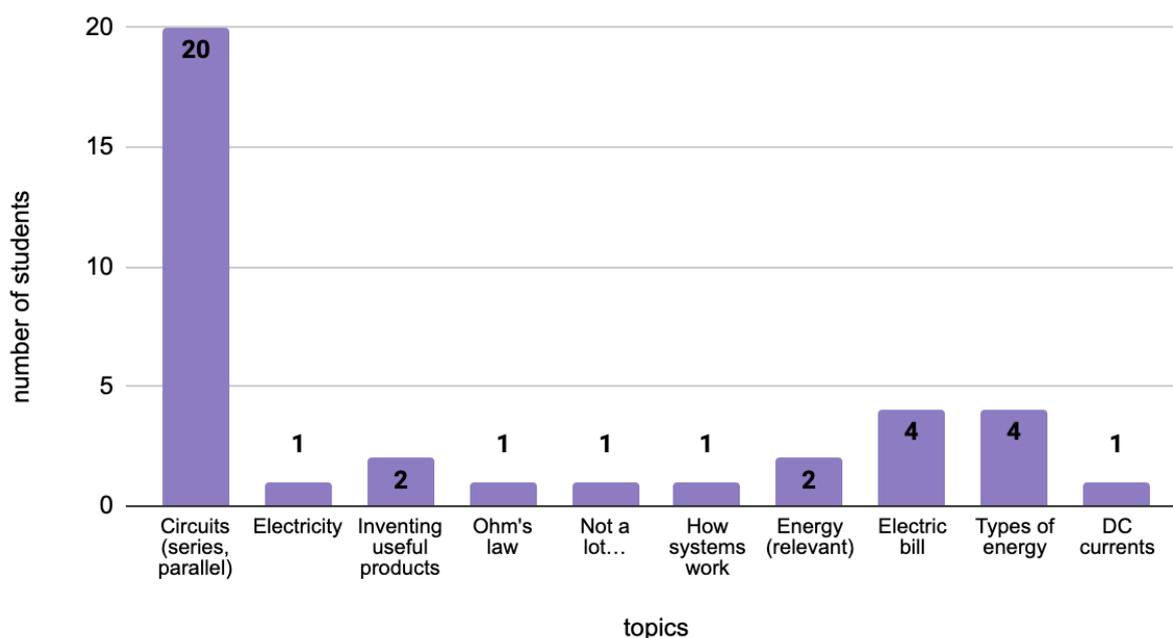
## 4. CONCLUSION

Looking at our data and student perspectives, we state that PBL is in fact a more engaging way of teaching inside classrooms. Hands-on processes and student focused activities make the students feel more involved with the subject they are developing, causing them to further understand the concepts. Motivating students to solve a problem related to their interests has shown to be effective in many ways: not only do students feel more engaged during lessons, but they look forward to using their newly learned topics and applying them to personal interests. To reinforce this statement with data, we found that 85.2% of the students felt engaged during the project (which is a lot!). The design thinking method is also an essential part of the learning processes inside PBL, where students are able to explore their creativity and expand their knowledge through non-linear and interactive activities. Taking all this into consideration, we think that PBL is a more fun and effective method of teaching, for both students and teachers.

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